TESTING THE PRODUCER'S MILK FOR QUALITY

By

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INTRODUCTION

In the earlier days of the dairy industry, information as to the quality of a given lot of milk could be obtained only through the senses of taste, smell and sight, no other means being then available for the purpose. With the development of the sciences of bacteriology and chemistry within recent years, however, more exact methods of testing have been devised to supplement the earlier ones. For some time the health departments in most large cities have been applying these scientific tests in order to protect the consumer from dirty, badly contaminated or adulterated milk. To-day, in addition to the health departments, up-to-date milk dealers are making use of these tests to protect consumer, dealer, and careful producer alike. By systematic testing and grading of incoming raw milk supplies, the dealer is able to eliminate milk unsuitable for bottling, and thus to improve the quality of milk offered to the consumer. In addition, the producer of milk of suitable quality is relieved of the unfair competition of low-grade milk produced with a minimum of sanitary precaution and consequent lower production costs. The maximum improvement in quality awaits the adoption of the practice of payment on a grade basis, whereby the price paid to the producer will vary in accordance with the quality as determined by suitable tests. Payment on a grade basis presents many difficulties, but these are gradually being overcome and the practice is slowly gaining ground. Success depends largely upon both dealers and producers being familiar with the principles involved, the tests available, and their relative suitability, for only under these conditions can best results be expected. There still appears, however, to be general lack of exact information on the part of those primarily interested, and the aim of the present bulletin is to present in unbiased fashion salient features in connection with milk quality and quality testing for the benefit of all concerned.

WHAT DO WE MEAN BY QUALITY IN MILK?

Before discussing methods of testing for quality it is essential that we have a clear idea of the meaning of the term "quality" when applied to milk. Quality in milk embraces five factors:—

(1) Food value.
(2) Freedom from dirt.
(3) Keeping quality.
(4) Safety to health.
(5) Freedom from off-flavours and odours.

All these factors must be considered when the quality of a given milk supply is being estimated, so that it is essential to consider each one a little more in detail.

(1) FOOD VALUE

Apart from its vitamine content, the food value of milk depends almost entirely upon the amount of fat and non-fatty solids (milk sugar, casein, albumin, mineral salts, etc.) contained. The richer the milk in these constituents, the higher its food value. The minimum standard set by Federal regulation requires 3·25 per cent fat and 8·50 per cent solids-not-fat, but a milk barely meeting these requirements would not be considered of high quality. The consumer attempts to judge the richness of the milk by the depth of the cream layer at the top of the bottle. Pasteurization tends to reduce the depth of this cream layer, hence this method of judging richness is unreliable when comparing raw with pasteurized milk. Nevertheless, keen competition between dealers in deepening this cream layer brings a demand for richer milk from the farms. Since the feed cost of producing milk increases as the percentage of the total solids rises, it is only fair that the price per hundredweight should vary accordingly. In earlier years a flat rate was paid for all milk regardless of its food value but at present the general practice is to adjust the price paid according to the fat test.[1]

(2) FREEDOM FROM DIRT

When a bottle of milk is held up and observed from below, any dirt or sediment which has settled to the bottom is clearly visible through the glass against the whitish background of the milk. A heavy sediment is soon noticed by the consumer, and usually leads to a change of dairies. Such dirt indicates carelessness in production or handling, for dirt has no place in any food product, particularly in milk. No milk showing a noticeable amount of sediment can be considered of high quality.

(3) KEEPING QUALITY

Early souring of milk is annoying to the consumer, and also to the milk dealer, for milk close to the point of souring cannot be pasteurized and bottled, and must be returned or otherwise disposed of. The consumer has a right to expect milk to keep sweet for at least twenty-four hours in a properly iced refrigerator, and spoilage within a shorter period indicates considerable growth of bacteria prior to delivery. This growth of bacteria may be the result of careless, unsanitary milking, insufficient cooling, or keeping milk too long before delivery.

Unfortunately some consumers are extremely careless in the handling of milk after delivery. Bottles of milk are allowed to remain outside in the hot sun, or in a hot kitchen, for hours, while all too frequently the temperature inside the refrigerator is far higher than it should be. Under conditions such as these, it is not surprising that milk occasionally sours in a shorter period of time, and the consumer has no legitimate cause for complaint when this occurs.

Pasteurization improves the keeping quality, but as it destroys only a certain percentage of the bacteria present, the keeping quality after pasteurization is affected by the number of bacteria present before heating. Many cities

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[1] If the price differential is to be proportional to the feed cost of producion, it is necessary to recognize that as the percentage of fat increases, the percentage of solids-not-fat rises much more slowly. Gaines (Illinois Agric. Exper. Station Circular 318, 1927) has made a study of this relationship and has found that the cost of producing milk is proportional to the *percentage of fat plus 2·66*. Thus the feed cost differential for a 3.5 per cent milk would be

$$100 \times \frac{0.1}{3.5 + 2.66} = 1.623$$

Where 3.5 per cent milk receives a base price of $2.40 per cwt. each point above 3.5 would receive 1.623 per cent of $2.40 or 3.9 cent. This formula offers the most exact method known for adjusting the price of milk in accordance with the feed cost of production.

require that pasteurized milk shall contain not more than a specified number of bacteria, hence the urgent necessity of the dealer obtaining milk with a low bacterial content from his suppliers.

(4) SAFETY TO HEALTH

Milk may be rich, clean, keep sweet for a long period, and yet be a source of danger to the public health. Outbreaks of typhoid, scarlet fever, septic sore throat and other diseases of human origin, in addition to that dread foe of young children, bovine tuberculosis, have been traced to the milk supply time and again. Consequently the factor of freedom from disease-producing organisms must be included under quality. Most large cities maintain a health department, one of the main duties of which is to reduce the possibilities of disease being spread by milk. Pasteurization, properly supervised, is universally regarded by public health authorities as being the strongest line of defence. In addition, the tuberculin testing of dairy cows, the periodical medical examination of dairy and milk plant employees, and home pasteurization of raw milk are all of value. The practice of pasteurizing milk in the home is urgently recommended for all localities where milk properly pasteurized is not obtainable. Were this universally adopted, much sickness and loss would be avoided and many lives saved.

(5) FREEDOM FROM OFF-FLAVOURS AND ODOURS

This, the last of the five factors influencing quality, should need little stressing. Milk with a flavour or odour foreign to that of good, fresh milk should never be offered for human consumption, yet at certain seasons, bad flavours and odours are all too common, and a considerable percentage of the milk arriving at the city plants would not grade very high under our definition of quality.

As we have seen above, quality in milk is a highly complex matter, embracing all five factors discussed. The extent to which the individual producer is justified in aiming for absolute perfection of product depends largely upon the requirements of the market he is supplying and upon the inducements offered to compensate him for the extra care taken. It is particularly in connection with the latter point that the practice of applying certain quality tests to milk is of importance, since without adequate means of measuring the comparative quality of different lots of milk it is scarcely feasible to put into operation a system of payment according to grade. These various quality tests will now be discussed at some length, in order that those interested in the matter may become familiar with them, and understand the advantages and disadvantages of each test.

QUALITY TESTS FOR MARKET MILK

FOOD VALUE

As previously mentioned, apart from its vitamine content the food value of milk depends almost entirely upon the amounts of fat and non-fatty solids contained. These two constituents occur in milk in a certain definite relation to each other, so that by determining the percentage of each, it is possible to detect milk which has been skimmed, watered, or skimmed and watered, in addition to milk which is naturally so low in these substances as to be below the minimum standard set by the Federal government. With the adoption of payment for milk on the basis of its fat content by most cities, little attention is paid to watering, skimming, etc., by the dealers, since the producer can gain nothing by such practice. However, in those districts where a flat price is paid, there is always a temptation for the producer of rich milk to reduce it to more nearly the composition of that of his neighbours. Under such conditions much time must be spent in checking up on possible adulteration of the milk.

FAT TEST

The percentage of butterfat in milk is commonly determined by means of the Babcock Test. In this test, strong acid is added to a measured volume of milk to free the fat from the casein, etc., and by adding hot water and whirling in a centrifuge at high speed the fat is floated up into the graduated neck of the test bottle, where the percentage of fat may be read off directly. Further details may be obtained from Dominion Department of Agriculture, Bulletin No. 14, New Series, entitledd, "The Testing of Milk, Cream and Dairy By-Products by Means of the Babcock Test."

There are other more delicate and exact methods for determining the fat percentage of milk, but these are rarely used in milk plants for the testing of shippers' milk.

SOLIDS-NOT-FAT

The chemical method of determining solids-not-fat by evaporating all moisture in an oven, to determine total solids, and then subtracting the fat percentage to obtain solids-not-fat, is rarely used as a routine method where large numbers of samples must be handled. Instead, use is made of the lactometer, which measures the specific gravity of the milk. Knowing the percentage of fat and lactometer reading, the solids-not-fat may be calculated by any one of several formulae, of which Babcock's is given here:—

$$\frac{\text{Lactometer reading}}{4} + \frac{\text{Fat percentage}}{5} = \text{Solids-not-fat}$$

FREEDOM FROM DIRT

SEDIMENT TEST

There are several types of testers on the market, but the principle is the same in each. A measured quantity of milk, usually one pint, is warmed slightly and forced through a small cotton disc, which filters out any insoluble dirt present. After drying, comparison with a set of standard discs (prepared from clean milk to which definite amounts of dry stable dirt have been added) reveals the amount of dirt present in the milk.[1] By such comparisons, the milk may be classified as (1) clean, (2) fairly clean, (3) slightly dirty, (4) dirty, (5) very dirty. Any sample falling below (2) is regarded as unsatisfactory.

The sediment test is a measure of one thing only—the amount of insoluble dirt which can be filtered out of the milk by passage through a cotton disc. *Dirt has no place in milk,* therefore the use of this test in grading milk is quite justifiable. Unfortunately, the employment of the sediment test too often results in greater care being taken to "clean" milk by thorough straining than to protect it from dirt by careful milking and handling. Straining may remove the undissolved dirt but it cannot take out the dissolved dirt or bacteria. Consequently, mere freedom from sediment is no guarantee of care and cleanliness in production.

On the other hand, it is practically impossible to produce a high grade milk containing few bacteria and have any more than a trace of sediment show upon the disc. Therefore, care in the production and handling of milk to protect it from dirt has a definite influence upon the keeping quality. While the bacterial content is not directly proportional to the amount of sediment, a milk showing heavy sediment is rarely low in bacteria. The type of dirt has a great deal to do with the number of bacteria added; fresh manure, for instance, generally adds far more bacteria in proportion to sediment than dried manure, stable

[1] Full details regarding this test, also the tests for keeping quality, are found in the Standard Methods of Milk Analysis, 5th Ed., published by the American Public Health Association, 370 Seventh Avenue, New York, N.Y., U.S.A.

dust, bedding, etc. On the other hand, milking machines and utensils, where not properly washed and sterilized, often add enormous numbers of bacteria to the milk, without ading a trace of dirt to show up in the sediment test. Consequently, the sediment test cannot be used to determine the probable keeping quality of the milk; this must be left to the proper tests, which will be described in the next section.

KEEPING QUALITY

Since the common spoiling of milk by souring is due to bacterial growth and activity, methods for the determination of keeping quality usually attempt to measure either the number of bacteria present or the amount of by-products of their growth present in the milk.

STANDARD PLATE COUNT OF BACTERIA

The plate count was the first satisfactory method devised for counting bacteria in milk, water, etc. and is still the standard for public health and other control laboratories.

In this method, a small measured quantity of diluted milk is mixed with a melted jelly-like nutrient medium and poured into sterile covered glass dishes. The jelly material hardens and holds the bacterial cells, or groups of cells, in place. Incubated at blood heat, single cells multiply until after 48 hours there are many millions formed. By this time each mass of cells, called a "colony," is visible to the naked eye. By counting these colonies and multiplying by the dilution, it is possible to estimate the number of bacteria present, which is expressed as the standard plate count per cubic centimeter (c.c.)[1] of milk.

No method has yet been devised by which it is possible to determine with absolute accuracy the number of living bacteria present in milk, and any count must be regarded as a careful estimate, subject to errors beyond the control of the analyst. For instance, many species of bacteria are present in milk in the form of clumps or groups, so that the actual number of bacteria present would be considerably greater than the number of colonies developing on the nutrient medium. Then again, certain species will not grow upon the nutrient used, or at blood heat, or else grow too slowly to be visible at the end of the incubation period.

The plate count is employed in milk control work chiefly by public health laboratories, and by milk plant laboratories for the examination of pasteurized, certified and other low count milk. Because of the necessity for a fully equipped laboratory and trained workers, and the limited number of samples which can be handled at one time, the method is too expensive to commend itself for routine analysis of milk as received from the farm. This field is more frequently left to the microscopic count or the methylene blue reduction method, which are less subject to the disadvantages just mentioned.

MICROSCOPIC COUNT OF BACTERIA (BREED'S METHOD)

The microscopic examination of a dried film of milk furnishes valuable information as to the number of bacteria present in unpasteurized milk. It is not suited to the analysis of pasteurized milk, however, since the bacterial cells killed in the heating process cannot be distinguished from the surviving cells. In addition, the analysis of high grade milk containing few bacteria is more difficult because of the extremely small amount of milk (generally 1/500,000 of a c.c.), visible in the field of the microscope at one time.

In the method devised by Breed, a small measured quantity of milk is spread over a definite area on a clean microscopic slide, dried, treated and stained to render the bacteria more clearly visible. The stained smear is then observed

[1] One cubic centimeter contains about 20 drops.

under a powerful microscope, and the bacterial cells visible in a number of different fields of the microscope are counted. Knowing the relation between the area of the microscopic field and the total area of the smear, the number of bacteria present in one cubic centimeter of milk may be readily estimated.

Since the Breed count represents the total number of bacterial present in the milk, while the plate count represents only the number of colonies developing, the former count is generally noticeably greater than the latter. A great deal of work has been done comparing the results of both methods when applied

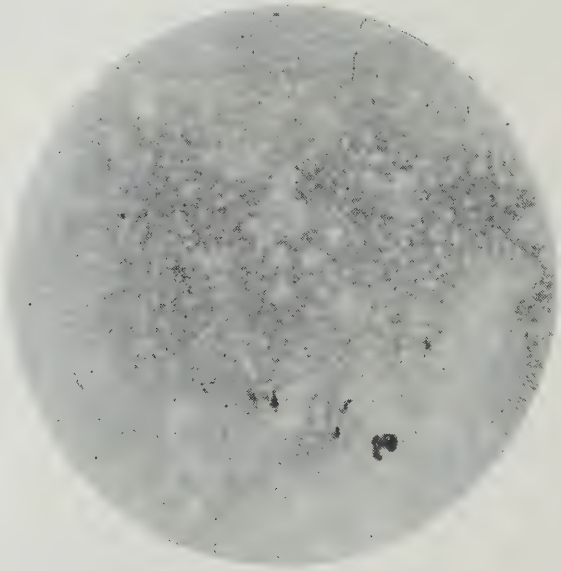

Fig. 1.—The appearance of milk of low bacterial content when viewed under a magnification of 600 diameters.

Fig. 2.—The same milk as shown in fig. 1, after remaining at 68° F., for 24 hours. Numerous bacteria are seen in the microscopic field indicating a count of millions per cubic centimeter.

to the same milk, and it has been found that on an average the Breed count is four times as high as the plate count. This factor naturally varies quite widely with individual milks, depending upon the extent to which the bacteria occurs in clumps or groups, and the number of cells in these clumps. If each clump of cells is counted as only one cell in the Breed method, the count obtained will correspond fairly closely to that obtained by the plate count.

In the examination of raw milk arriving at the pasteurizing plant, it is rarely necessary for an experienced analyst to make actual counts of each shippers' milk, except where the sample appears to be on the borderline between grades. Consequently, a large number of samples can be analysed in the course of a day, and each lot of milk given a grade corresponding to a bacterial count lying between certain limits. A well-trained analyst is also able to indicate the probable source of high bacterial counts, especially where these are due to udder trouble, poorly sterilized utensils, or insufficient cooling. Against these advantages must be set the fact that there is considerable eye strain involved where a large number of samples must be examined at one time. There is also the possibility that persons inexperienced with microscopic work may mistake small specks of extraneous matter for bacteria, and where high-grade milk is being examined, such errors might seriously affect the grade given the milk.

METHYLENE BLUE REDUCTION TEST (REDUCTASE TEST)

This test, commonly called the "Blue Test", was developed by bacteriologists in Scandinavia, where it has proved extremely useful in the grading of milk supplies. The test is based upon the discovery that bacteria growing in milk to which a dye such as mythelene blue has been added are able to reduce the dye to a colourless form. The more bacteria there are in the milk, the sooner the colour will disappear. Therefore, the time required to decolourize the milk is roughly proportional to the number of bacteria present.

The test, as described in Standard Methods of Milk Analysis, is conducted by adding 1 c.c. of a standard solution of methylene blue to 10 c.c. of milk in a test tube, mixing thoroughly, then placing the tube in a water bath at blood heat; the tube is then observed at certain stated intervals until the blue colour has disappeared. The Scandinavian classification, officially adopted on this continent, is as follows:—

Class 1. Good milk, not decolourized in 5½ hours; plate count generally less than one half million per c.c.

Class 2. Milk of fair average quality, decolourized in less than 5½ hours, but not less than 2 hours; plate count, as a rule, one half to four million per c.c.

Class 3. Bad milk, decolourized in less than 2 hours but not less than 20 minutes; plate count, as a rule, four to twenty million per c.c.

Class 4. Very bad milk, decolourized in 20 minutes or less; plate count, as a rule over twenty million per c.c.

There are other classifications in use which differ somewhat from the one outlined above, but the Scandinavian classification seems to be adequate under most conditions.

The methylene blue test has been widely adopted on this continent during the past few years, and has shown itself to be extremely useful in the rapid grading of milk as received from the farm. Among its advantages may be listed the fact that information as to the quality of milk is obtained quite rapidly, thus facilitating the work of fieldmen; the poorest milk is detected first; the apparatus required is relatively simple and inexpensive; the test may be conducted by anyone of average intelligence; a large number of samples may be handled in one day; and the milks are readily classified by observing them for decolorization at the end of the various periods.

Where the test is applied to milk containing few bacteria, the relation between reduction time and keeping quality is more variable. For this reason

it cannot be depended upon to make fine distinctions between milks of the highest grade. Recent studies[1] tend to show that the methylene blue test gives a better indication of the actual keeping quality of the milk than does the bacterial count by the standard plate method. In any event, the test is a very valuable one for the milk receiving plant, and promises to come into general use in the near future.

FERMENTATION TEST

There are several fermentation tests, which differ slightly from each other. In general, a measured quantity of milk is incubated in a sterile tube at blood heat, and the changes taking place observed at various intervals. These tests were designed to assist the cheesemaker in judging the condition of the milk to be used in cheesemaking, where the presence of gas-producing bacteria in any numbers may cause considerable trouble and loss. The presence of these bacteria is indicated by the type of curd formed when the milk clots. Occasionally a fermentation test (generally in combination with the methylene blue test) is conducted by a milk dealer on milk from the farm, but because of the difficulty in properly interpreting the results in relation to keeping quality, the value of this practice is still in doubt.

ACIDITY TEST

This method is extremely useful as a means of confirming the suspicions of the man inspecting in the receiving room. Where acidity has developed from the growth of bacteria (as when milk has not been properly cooled), a trained man can readily detect the fact by his sense of smell. Should such milk contain more acid than allowed, it would be rejected as being too near souring to be satisfactory for condensing, powdering, or the city milk trade.

In this test, the quantity of acid present in the milk is measured by gradually adding a standard solution of alkali until a chemical indicator shows by a change of colour that no more acid remains. The acidity is then calculated and expressed as the percentage of lactic acid present.

The maximum acidity accepted for market milk is usually 0·18 per cent, although higher and lower values are occasionally used. Milk freshly drawn from healthy cows has occasionally been found to contain a higher acidity value than 0·18 per cent, but it is rare for the mixed milk of a herd to exceed 0·15 per cent. Where milk is cleanly produced and thoroughly cooled, the increase in acidity within 24 hours is so small that it can scarcely be measured and such milk would never lead the inspector to suspect high acidity. In any case, where the acidity test is used only to confirm the inspector's suspicions, there is no reason for believing that milk of good keeping quality would be condemned.

Unlike the other tests for keeping quality considered so far, this test enables information to be obtained within a few moments, so that milk suspected of abnormal acidity may be rejected. With the other tests, the information is ordinarily obtained too late to prevent the mixing of undesirable milk with the satisfactory supply, and can best be used as a measure of the grade of milk being shipped by any particular producer over a period of time.

TEMPERATURE

Other things being equal, well cooled milk will remain sweet longer than warm milk. This has been known for generations, and prompt cooling of milk on the farm or in the milk plant is a general practice. Because temperature is an important factor, the attempt is sometimes made to judge the keeping quality of milk by taking the temperature. Such a practice frequently yields misleading results, and is unsatisfactory to all concerned.

[1] A comparison of the methylene blue reduction test and the agar plate count for determining quality of milk. Ellenberger, H. B., Bond, M. C., Robertson, A. H., and Moody, R. I. Vermont Agr. Exper. Sta. Bul. 264, 1927.

Milk may become contaminated with enormous numbers of bacteria where milking machines or utensils are not properly cared for, or where cows are suffering from garget. Where the temperature is the only criterion of keeping quality, such milk, if well cooled, will pass as being satisfactory. On the other hand, morning's milk produced under sanitary conditions may have to be shipped before it has cooled sufficiently. Such milk, together with other high-grade milk which has warmed up during shipment, would be condemned by the thermometer, while in reality possessing keeping quality infinitely superior to that of the unsanitary but well cooled milk discussed above.

Poor keeping quality means large number of bacteria in the milk. These bacteria are the result of one or more factors—initial contamination (from cow's udder, milker's hands, utensils, etc.), length of period between milking and delivery at factory, and the temperature at which it is held during this period. In tests such as the methylene blue test, microscopic count, plate count, etc., these three factors are all considered; such tests are therefore much more reliable measures of keeping quality than the thermometer method, which measures but one factor and disregards the others.

OTHER QUALITY TESTS LESS COMMONLY EMPLOYED

In addition to the tests already described, the following ones have been developed and are used in certain places for determining the sanitary quality of milk.

Frosts's Little Plate Method combines certain features of the standard plate count and the microscopic count of Breed. A small quantity of milk is mixed with the jelly-like medium and spread over a measured area on a microscopic slide. This is then incubated for 6-8 hours, dried, stained, and the colonies which have formed from the growth of bacteria counted under the microscope. Despite certain advantages, this method has not achieved the popularity of some of the tests previously described.

The B. coli Test is used to detect the presence of bacteria forming both acid and gas in milk. It is usually carried out by inoculating varying amounts of the milk being examined into test tubes containing a broth to which milk sugar has been added. Within the test tube is a small inverted vial, which collects any gas formed from the fermentation of the sugar.

Since *Bacillus coli* occurs abundantly in human and animal excreta, the presence of gas producing bacteria in milk is sometimes stated to be an indication of pollution with manure. Other gas forming bacteria, closely related to *Bacillus coli,* are widely distributed in nature, being found in soil, poorly sterilized utensils, grains, silage and other fodder, hence the interpretation of results obtained by this test is difficult. Although the test is sometimes used to advantage in control work with pasteurized milk, it does not appear to be of sufficient value to justify its use for the routine testing of shippers' milk.

The Alcohol Test, in which equal quantities of milk and 68 per cent alcohol are shaken together, is sometimes used in detecting abnormal milks. If the milk is abnormal, flakes of casein appear. This may be the result of udder trouble, the presence of colostrum, disturbances in the balance of mineral salts, or to changes produced in the milk by the growth of acid or rennet-forming bacteria. Since bacterial action is only one of these factors, the value of this test in determining the extent of bacterial contamination is limited.

The Brom Thymol Blue Test (Cooledge) is used to measure the extent of bacterial contamination by observing the rate at which acid is produced in a broth medium inoculated with a small quantity of milk, when incubated at blood heat. The broth contains a chemical indicator which indicates by a change of colour the degree of acidity present at any time. Badly contaminated milk brings about a rapid change of colour, while milk containing few bacteria shows little or no change after eight hours.

This test is open to the objections that the bacteria are required to grow in a medium quite different from milk, and that as only acid formation is

measured, those types not able to produce acid are disregarded. Comparative studies of this test, the brom-cresol purple test, and the methylene blue reduction test, have shown the latter to be preferable because of its greater sensitiveness to biological differences in milks because it measures the number of bacteria rather than one of the by-products of their growth, and because of its simplicity and practicability.[1]

The Brom Cresol Purple Test (Baker and Van Slyke) measures the acidity produced in milk to which a chemical indicator is added, the test being conducted at approximately room temperature. Increasing acidity gradually changes the colour of the indicator, and the rapidity of acid formation indicates the relative abundance of bacteria. As mentioned above, it is not as valuable as the methylene blue reduction test in determining keeping quality, but has some value in detecting abnormal milks from diseased udders, etc.

SAFETY TO HEALTH

Quite apart from specific pathogenic bacteria, milk containing large numbers of organisms not usually considered to be disease-producing has been frequently established to be the cause of complaints such as summer diarrhœa of infants. Such disturbances are usually brought about by the ingestion of enormous numbers of bacteria, resulting in excessive fermentation and putrefaction in the digestive tract. For the detection of milk of this type, no special tests are usually required other than those already outlined for keeping quality.

Milk, however, is more commonly dangerous to human health when containing specific disease germs. These may be present in the milk as drawn from the udder, as in tuberculosis, undulant fever and septic sore throat, or may be introduced from human sources (typhoid, dysentery, scarlet fever, cholera, human tuberculosis, etc.) during milking and subsequent handling. In many cases the disease germs comprise an insignificant proportion of the total bacterial content, and it is rarely possible by ordinary analytical methods to demonstrate their existence in a given sample of milk. In most cases methods must be resorted to which are far too expensive and time-consuming to be used in the routine examination of milk supplies.

Since there are no tests available which are sufficiently practicable, public health authorities strive to reduce the amount of milk-borne disease by insisting upon sanitary methods of production and handling, disease-free dairy herds and employees, properly supervised pasteurization to destroy any disease germs which may have entered the milk, and proper protection from recontamination after pasteurization. By giving careful attention to all these points the health departments in most of the large cities have almost completely eradicated milk-borne disease. In the smaller communities, this phase of health work has received less attention, and raw milk, often produced under dubious sanitary conditions and from diseased cows, is unfortunately still all too common. Where a supply of properly pasteurized milk cannot be obtained, raw milk of the best quality obtainable should be pasteurized in the home.[2]

FLAVOURS AND ODOURS

Because the substances responsible for undesirable flavours and odours in milk are present in quantities too small to be detected by chemical analysis, there are no tests available for their detection other than the senses of taste and smell. Since an abnormal flavour or odour is so readily detected by the consumer, the man inspecting milk arriving at the plant must be constantly on guard to prevent milk with a bad flavour or odour from being mixed with the

[1] The relative value of the methylene blue reduction test, the brom thymol blue test and the broom cresol purple test in determining the keeping quality of milk. Hastings, E. G., and Davenport, A. Jour. of Dairy Science, Vol. 3, p. 353-366, 1920.

[2] A fuller discussion of the process of pasteurization, with directions for pasteurizing milk in the home, will be found in Publication No. 36 issued by the Dominion Department of Health, Ottawa, entitled, "Pasteurization of Milk for Small Communities."

remainder of the supply. Slight flavours from certain feeds often pass off during the pasteurizing process, but where garlic, gasoline, musty, rancid, disinfectant, or other objectionable flavours are encountered, such milk should be rejected as being unsuitable for human consumption.

GRADING MILK ON A QUALITY BASIS

Since the milk dealer must supply his customers with as high a quality of milk as they demand, he in turn must take steps to ensure that the milk he purchases from each individual producer comes up to a reasonable standard, as judged by the tests described above.

The evolution of a single plan for grading milk on a quality basis which could be followed successfully in every district is too much to hope for. When the variation in conditions between different localities—different customs and practices which have grown up, different breeds of cattle, different standards of requirements by health departments and consumers, different systems of marketing, different climatic conditions, etc.—is considered, together with the complexity of the problem of giving proper weight to each of the factors involved in the determination of quality, the difficulty of achieving such an aim becomes apparent. This does not mean that grading cannot be successfully applied in every locality. Rather, it means that the system adopted in each district must be designed with careful reference to local conditions.

In spite of the obstacles in the way of formulating a single plan applicable to all conditions, there are nevertheless certain general principles which should be borne in mind in regard to the development of a system of grading milk. The first, and most important, is that high-quality milk—milk rich in fat, clean, of good keeping quality, free from objectionable odours or flavours, from healthy cows—is a more valuable product than milk lacking one or more of these desirable characteristics. The man producing the high quality milk should receive a higher price than the producer of lower grade milk. When this is carried out there is a definite financial incentive to everyone to produce a high grade of milk.[1]

Other principles to be borne in mind include the use of the most suitable tests for determining quality, and the development of a grading system which is not too elaborate or complicated. A satisfactory system should make provision for daily sampling of milk for a periodical composite Babcock test, for the detection of off flavours, odours, bloody milk, etc., by the man inspecting the incoming milk and for the rejection of milk unsuitable for human consumption; for the periodical testing of sediment, preferably weekly; and for a similar periodical testing for keeping quality by one of the suitable tests previously discussed. Such a system would entail little extra work at the receiving plant, and would provide sufficient information for the ranking of the shippers in order of merit.

Finally, a system of grading must take into account local conditions, such as the present quality of milk supplied, the relative shortages and surpluses at different seasons, and the competition from other outlets for milk. Unless this is done, a grading system can scarcely be expected to give maximum satisfaction to all parties concerned.

It is regrettable that in certain districts producers have shown considerable hostility to the idea of grading milk, regarding it simply as a device whereby additional work is imposed upon them without any financial compensation. While adjustment of the price paid the producer in accordance with the grade of milk supplied has been attempted in only a few districts, the majority of

[1] One of the most promising systems in this connection is the ranking of each shipper in order of merit for each month, the forwarding of a full report of standing to each farmer and the payment of a bonus to a certain percentage at the top—say 10 or 15 per cent of the shippers. Such a system not only rewards the careful producer but also stimulates keen rivalry among neighbours for the honour of standing highest in the district. In addition the distributor knows in advance the total cost of the premiums.

dealers fully realize the justice of the underlying principle but have not yet found a satisfactory basis for grading and price differentiation. While payment on a grade basis is the quickest method to obtain an improvement, and the easiest means of maintaining quality at a high level, yet even where no difference in price exists, the producer of high grade milk benefits through the gradual elimination of the careless shipper who consistently fails to meet the standards set. This tends to reduce the competition in the city milk field since the careless producer must eventually drop out of dairying or seek some other avenue for the disposal of his milk. The production of milk for the city trade is becoming more and more a specialized line, in which a knowledge of the details concerning the production of a high grade product is a necessity. No article of food has such a direct relation to the nation's health, and the public are quite within their rights in demanding that the old time dairyman, with his careless habits and limited knowledge of sanitation, shall give way to the better trained, more careful producer.

APPENDIX

METHODS OF TESTING EMPLOYED BY MILK PLANTS THROUGHOUT CANADA

In order to obtain information regarding testing and grading as conducted at the present time, a questionnaire was submitted to milk distributers in forty-seven towns and cities throughout Canada. Information was requested covering the kinds of tests employed and their frequency; whether the producer was paid for his milk on a grade basis; basis for rejection of unsuitable milk, etc. Questionnaires were submitted to 186 milk distributers, of whom 37 replied, the reports received being briefly summarized in the following table:—

SUMMARY OF REPLIES TO QUESTIONNAIRE ON TESTING AND GRADING MILK

Test	Number of dealers employing	Number of shippers tested	Number of dealers using as basis for grading[1]	Number of dealers using as basis for price paid[2]
Sediment	33	6,181	24	4
Temperature	27	5,212	8	1
Acidity titration	26	4,814	24	0
Methylene blue reduction	15	4,081	8	2
Standard plate count	8	772	1	1
Fermentation	3	206	0	0
Microscopic count	2	183	0	0
Little plate count	0	0	0	0
Brom-thymol-blue	0	0	0	0
Brom-cresol-purple	0	0	0	0
Alcohol	0	0	0	0
B. coli	0	0	0	0

[1] This includes dealers using test as a basis for rejection.
[2] This does not include dealers who accept "Rejected" milk at lower prices.

While such tests as the sediment test and the methylene blue reduction test are commonly applied to all shipments of milk received, other tests such as temperature and acidity titration are more frequently used only where milk is suspected of being high in temperature or acidity, and are not usually applied to all incoming milk as a routine procedure.

A study of the individual replies received reveals the significant fact that only 19 out of the 37 plants are employing any test other than acidity and temperature in determining the keeping quality of the incoming milk. Since a satisfactory grading of raw milk supplies is much more easily accomplished through the methylene blue reduction test or microscopic count it is to be hoped that tests of this type will soon replace the determination of acidity and temperature as routine practices for measuring keeping quality.

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